August Program Highlights

NASA Satellite Data Will Help Improve Aviation Safety

Patrick Minnis, LaRC, Hampton, VA

Highlight:

NASA Langley (LaRC) near-real time cloud products are being assimilated into the NOAA Rapid Refresh (RR) numerical weather prediction model that serves as the next generation aviation weather forecast model for North America. This Applied Sciences sponsored project marks the first time that near real-time satellite imager cloud products have been assimilated into aviation forecast model. Prior to using the LaRC cloud products, the model produced too much tropical convection and too few clouds over Canada compared to the satellite observations (top panels). After incorporating the LaRC clouds, the model starts its forecast cycle with much more realistic clouds (bottom panels).

Relevance:

Many aviation safety hazards are associated with clouds (e.g., heavy precipitation, lightning, low ceilings, icing, etc.). Forecasting cloud location, height, phase, and water content require that the model starts with an accurate representation of the cloud field before it starts calculating its forecast. By assimilating the LaRC GOES and MODIS-based products, the RR begins its forecast cycle with a very accurate cloud field. Other cloud parameters such as liquid and ice water path have also been tested and also yield improvements in several model parameter (e.g., ceiling height, relative humidity) predictions. Improved forecasts directly aid the decision making process for aviation safety warnings.

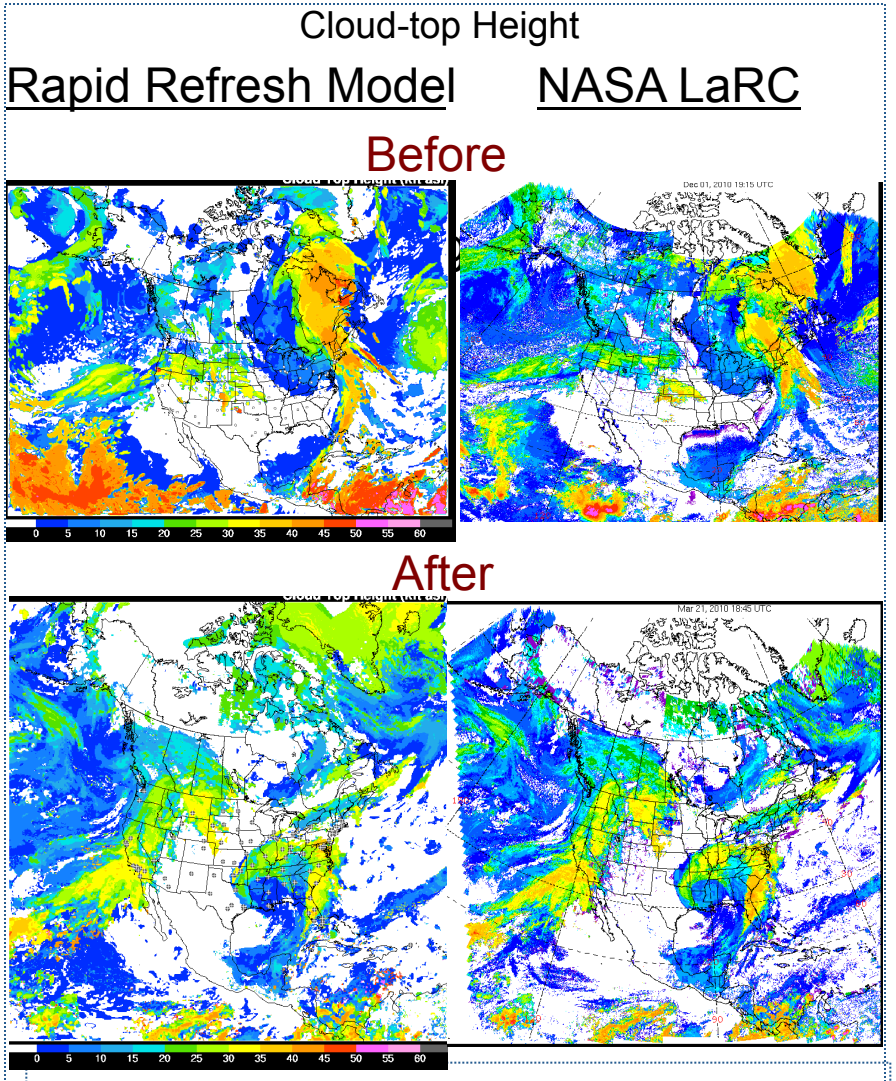

Figure 1. Top shows a typical comparison of cloud-top heights in the RR model before assimilating LaRC cloud products. Bottom demonstrates the improvement typical in the results when LaRC products are assimilated.

ESD Applied Sciences Program

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Project Summary:

Project was established to determine if assimilation of cloud properties derived form imager data could improve aviation weather forecasts. NASA LaRC would provide the cloud products to the NOAA ESRL modeling group led by Stan Benjamin. They worked together to alter the model and cloud products so that they could be assimilated into the NOAA Rapid Refresh (RR) and Rapid Update Cycle (RUC) models. The initial tests were performed with the RUC and showed that incorporation of the LaRC cloud heights and liquid and ice water path data improved the forecasts of cloud ceiling heights and relative humidity. The cloud distributions, in general, were also improved with subsequent expected improvement in the forecasts of icing conditions, especially in remote areas. Due to physical limitations of the model, only the cloud top heights have been retained in the assimilation process to date. More study is needed to fully utilize the other products. Since the RUC is being phased out and replaced by the RR in September, all further tests were performed using the RR model. They were successful and NOAA requested that the real time products be made available operationally. LaRC performs all analyses of the GOES and, soon, MODIS data on Project Columbia. The results are transferred to the National Centers for Environmental Prediction (NCEP) where they are disseminated to ESRL and other users.

Earth Science Products: Cloud properties derived every half hour over North America from the operational GOES East and West satellites using NASA-developed algorithms are provided to NCEP. Further development using the Terra and Aqua MODIS data over the polar regions will be completed soon and provided as part of the cloud property package.

Technical Description of the Images: Images show cloud-top heights as initialized by the RR and compared to LaRC GOES-derived heights. Top shows how different they are for a case with no LaRC clouds and close they are for adding the LaRC clouds in the assimilation process.

Application to Decision Making: The work from this project yields more accurate forecasts of clouds and cloud top heights. This allows the aviation forecasters to determine the locations of aviation hazards more accurately and produce more confident decisions about warnings.

Scientific Heritage: This work is a spinoff of cloud analyses of MODIS data by the NASA CERES program and the ground work of Stan Benjamin at NOAA Earth System Research Laboratory (ESRL).

References: **http://www-angler.larc.nasa.gov/** Minnis, P.,et al., 2008: Cloud detection in non-polar regions for CERES using TRMM VIRS and Terra and Aqua MODIS data. *IEEE Trans. Geosci. Remote Sens.*, **46**, 3857-3884.

Minnis, P., et al., 2011: CERES Edition-2 cloud property retrievals using TRMM VIRS and Terra and Aqua MODIS data, Part I: Algorithms. *IEEE Trans. Geosci. Remote Sens.*, **49**, *11*, doi: 10.1109/TGRS.2011.2144601, in press.

BlueSky Systems Use Greatly Expanded with Aid of NASA Data

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Highlight:

Introduction of NASA data in a routine and operational sense helped grow users for BlueSky Systems and is now used to routinely assess air quality impacts of fires. Initial users were only in the Pacific Northwest region and have since grown to expand across the Unites States and Canada. Furthermore, the inclusion of NASA data has provided better fire information, refined scientific component models and settings and improved systems reliability.

Relevance:

BlueSky is an existing tool that is being used my multiple agencies and has a direct and immediate impact on decision making. BlueSky is used by EPA for its National Emission Inventory and by land managers and fire managers across the U.S. for operational decisions concerning prescribed burning and wild land fire-fighting. Local air quality agencies benefit by issuing air quality alerts and for preparing analyses of exceptional events. Moreover, expanded users include a community of fire science researchers participating in the Smoke and Emissions Model Intercomparison Project.

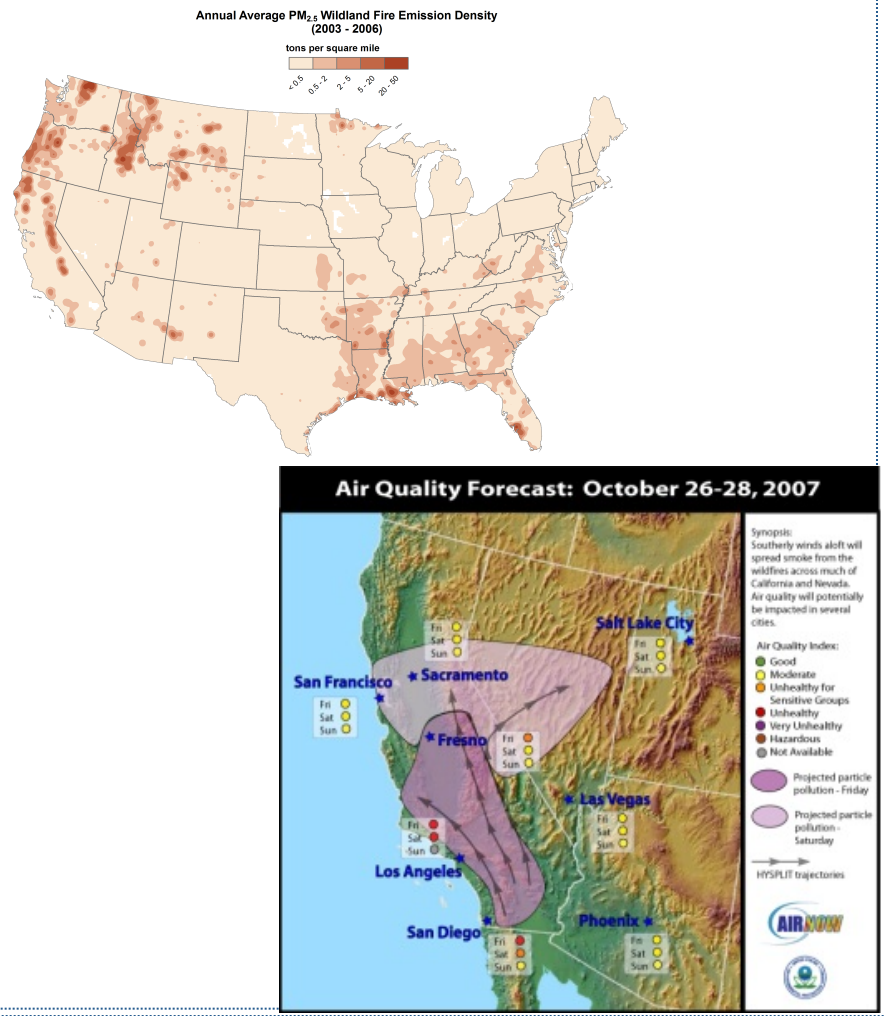

Figure 1. New applications of BlueSky systems, enabled by NASA ASP program: wild land fire emission inventories for EPA's National Emission Inventory (top); and smoke impacts assessments for air quality alerts or exceptional events analyses (bottom).

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Project Summary: The project's purpose was to improve decision-support information about fires and associated air quality impacts as routinely accessed by land managers, fire managers, and air quality agencies across the U.S. To meet this purpose, the project team improved pre-existing decision support tools—i.e., BlueSky systems—which (prior to this project) were referenced regularly only by a limited constituency of users in the Pacific Northwest. The key development was the introduction of remotely sensed fire data as a routine and operational input to BlueSky. By the project's conclusion, the community of regular BlueSky users had expanded across the U.S. and into Canada, and measurable improvements in system reliability and predictive accuracy were achieved. These results were enabled by NASA satellite-based instruments providing reliable and universal information about fires.

Earth Science Products: Fire information for BlueSky is acquired through the National Oceanic and Atmospheric Administration's (NOAA) Hazard Mapping System (HMS). HMS is a quality-controlled fire and smoke analysis for the U.S. produced by the Satellite Services Division of NOAA's National Satellite and Data Information Service and updated several times per day. HMS integrates satellite data from three instrument types (MODIS, Geostationary Operation Environmental Satellite [GOES], and Advanced High Resolution Radiometer [AVHRR]) on board seven different satellite platforms.

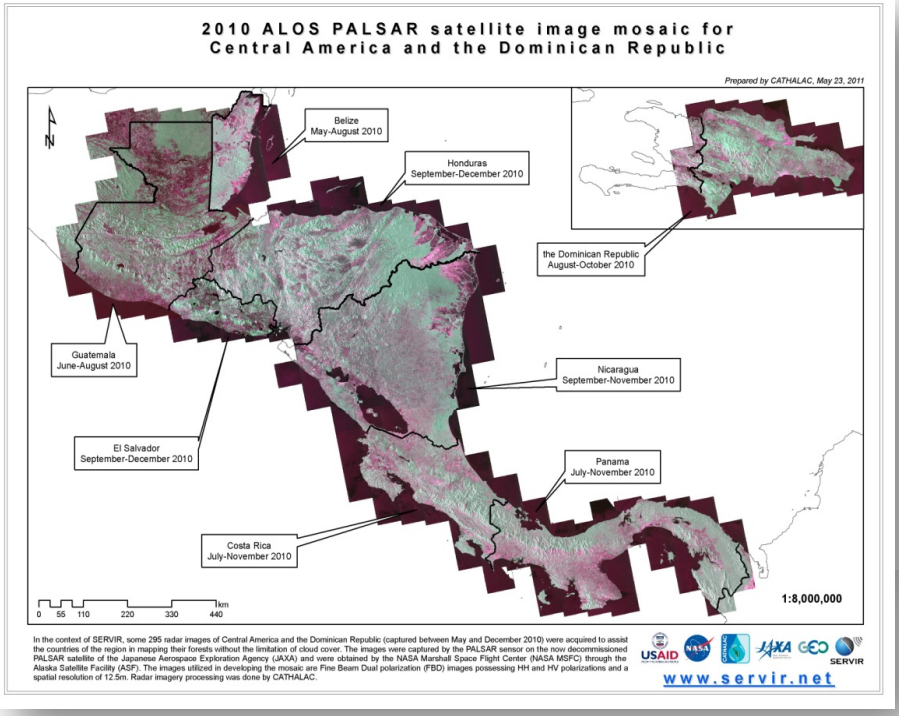
Technical Description of the Images: (top) Emissions density plot of fire emissions as estimated for the U.S. Environmental Protection Agency's (EPA) National Emission Inventory; and (bottom) illustration of smoke impacts assessments for air quality alerts and/or exceptional events analyses.

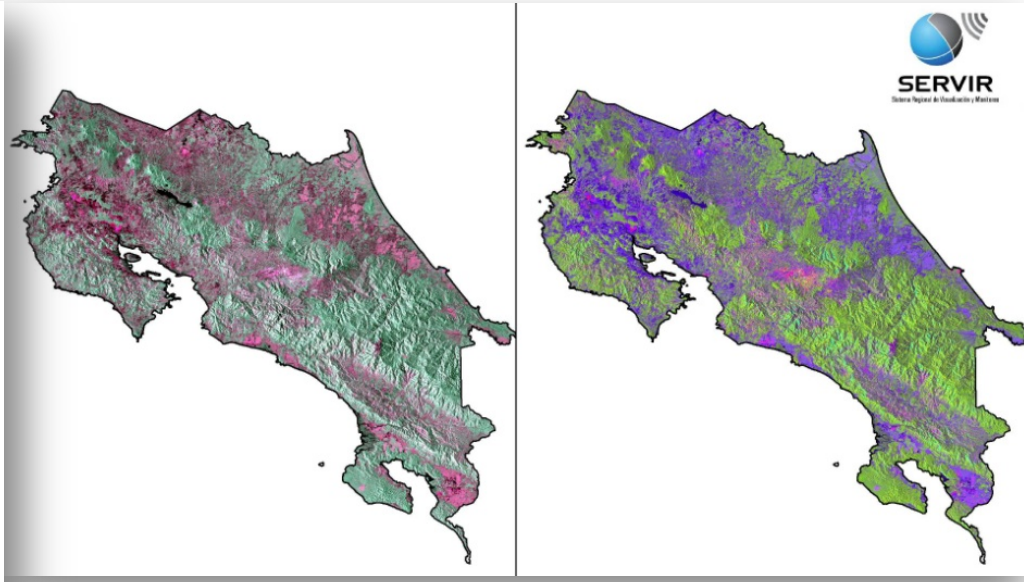
Application to Decision Making: BlueSky systems facilitate evaluations of the air quality impacts of fires in the context of public policy decision making and scientific research. Land managers and fire managers use BlueSky systems to make operational decisions about prescribed burns and wild land fire-fighting programs. Air quality agencies, regional planning organizations (RPOs), and the EPA use BlueSky systems to support analyses and policy decisions related to the Regional Haze Rule, National Ambient Air Quality Standards (NAAQS), State Implementation Plans (SIP), and the National Emission Inventory (NEI). Researchers in the fields of fire sciences and atmospheric sciences apply BlueSky systems to study and improve the underlying science and behavior of fire science models (i.e., models representing fuels, fuel consumption, emissions rate, and pollutant dispersion). All of these users benefit greatly from routine access to reliable and universal information about fires for use in decision-support systems.

Scientific Heritage: The BlueSky Framework was originally developed in 2001-2002 as a tool for prescribed burners to assess the smoke impacts of their proposed fires. The success of BlueSky contributed in part to the USDA Forest Service's decision to invest in five regional modeling centers (Fire Consortia for the Advanced Modeling of Meteorology and Smoke, FCAMMS). In 2005, in response to a request from the EPA, BlueSky was evaluated for use in predicting wildfire smoke impacts—an effort that culminated in the 2005 BlueSkyRAINS West demonstration project. The findings of this interagency project of the Department of the Interior, USDA Forest Service, and the EPA noted the significant potential of BlueSky, but also identified several issues impeding operational adoption. In particular, several needs were highlighted, including the need for (1) better fire information—especially satellite-based observations and higher quality and more timely Incident Command Summary (ICS)-209 reports—that should be widely available via electronic data transmittal; (2) improved reliability of the software producing increased operational "uptime"; (3) scientific refinements to component models and settings (e.g., technical issues with models of plume rise, boundary layer structure, smoldering emissions, weather, carryover smoke, and fire growth); (4) sound management, policy, and funding decisions concerning BlueSky (e.g., multi-year funding, coordinated participation of stakeholder agencies, and structured plans for moving from experimental to fully operational status); (5) rigorous testing, evaluation, and validation programs; and (6) greater movement toward meeting user needs, expanding the scope of the user community, and promoting national acceptance of the system by key stakeholder agencies. With this recognition of BlueSky's potential (as well as the acknowledgment of needed improvements), development of BlueSky and collaboration with the National Weather Service (NWS) continued. These efforts resulted in adoption of BlueSky emissions calculations into the NWS smoke forecast products (deemed experimental in 2006 and operational in 2007). The NASA-funded project discussed in these highlight slides has addressed many of the issues identified by the 2005 BlueSkyRAINS West project and has advanced the state of the science and modeling for smoke impacts evaluations.

SERVIR Serves Up Mosaic of Central America

SERVIR is working with the governments of the Central American countries to developed improved land cover maps using 2010 ALOS PALSAR data. 295 radar images of Central America and the Dominican Republic (captured between May and December 2010) were acquired to assist the countries of the region in mapping their forests without the limitation of cloud cover. The images were captured by the PALSAR sensor on the now decommissioned ALOS satellite of the Japanese Aerospace Exploration Agency (JAXA) and were obtained by NASA through the Alaska Satellite Facility (ASF). The images utilized in developing the mosaic are Fine Beam Dual polarization (FBD) images possessing HH and HV polarizations and a spatial resolution of 12.5m. Radar imagery processing was done by CATHALAC/SERVIR.





Above (left scene) is the raw radar mosaic of Costa Rica. The processed image to the right show the areas of forest cover. The countries are using these images to support REDD+ activities in the region.